bastante desarrollado, siendo de 85 mm de largo en la hembra en estudio. Esto pareciera ser parte de las adaptaciones de esta especie a consumir mayor cantidad de material vegetal que otras dentro de su mismo grupo, y por ende a digerir mayor cantidad de fibra.

Los osos hormigueros (*Myrmecophaga tridactyla*) son insectívoros estrictos y tienen un intestino delgado que es siete veces el largo del cuerpo y un intestino grueso similar en longitud al cuerpo. Opuestamente a lo que se podría deducir, debido a que el peludo es más omnívoro en cuanto a sus hábitos alimenticios, el intestino delgado y el grueso del peludo en estudio es en relación al cuerpo relativamente más corto (5,7 y 0,91 veces el largo del cuerpo) que el de los osos hormigueros (7 y 1 veces el largo del cuerpo respectivamente) y el de las mulitas (*Dasypus sabanicola*) (8,29 y 0,825 veces el largo del cuerpo respectivamente), según datos de Stevens y Hume (1995). Considerando otros omnívoros podríamos citar al oso negro (*Ursus americanus*), cuyo intestino es aproximadamente diez veces el largo del cuerpo, sin distinción entre intestino medio y grueso (Stevens y Hume, 1995). No obstante, para poder determinar la razón por la cual el peludo tiene intestinos relativamente cortos, teniendo en cuenta sus hábitos alimenticios, deberíamos tener más datos que confirmen estas dimensiones. Ya que si estos datos se repitieran podríamos suponer que estamos frente a un animal que solo consume hierbas cuando no tiene otros alimentos disponibles, es decir un verdadero oportunista.

Conclusiones

Dado el carácter preliminar de la información obtenida a través de un único individuo, se hace necesario en el futuro contar con más ejemplares—provenientes tanto del cautiverio como de la naturaleza—a los efectos de establecer valores promedio para la especie, sexo y grado de madurez de los individuos.

Agradecimientos: A Julieta Esmaimann, cuidadora Semi-Senior de Fundación Temaikèn por su colaboración en la necropsia, y procesamiento y toma de fotos; y a las Lic. Biol. Soledad Magallanes y Carolina Beltrami, miembros del Departamento de Conservación de Fundación Temaikèn, por la colaboración en la corrección del trabajo y en la búsqueda bibliográfica.

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A Range Extension for the Yellow Armadillo, *Euphractus sexcinctus* Linnaeus, 1758 (Xenarthra: Dasypodidae), in the Eastern Brazilian Amazon

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Introduction

Euphractus sexcinctus, the yellow or six-banded armadillo, is the largest of the five species of euphractine armadillos, also known as the hairy armadillos (Wetzel, 1985; Eisenberg and Redford, 1999). Yellow armadillos are distinguished by short ears and a flattened head that becomes triangular toward the snout, protected by large plates with patchy fur (Nowak, 1999). The upper body is light yellow, bronze or red-

dish, with six to eight mobile bands on the carapace. An adult animal's head and body measure approximately 401–495 mm, and it weighs 3.2–6.5 kg. Its tail is short and cylindrical, with plates arranged in two to four separate bands at the base. All five toes on each paw have claws, the second of which is the longest (Nowak, 1999).

The geographic distribution of *E. sexcinctus* covers much of eastern South America, ranging from the southern mouth of the Amazon through all of southeastern Brazil, and extending into Uruguay, Paraguay and northeastern Argentina, as well as eastern and central Bolivia (Wetzel, 1985; Redford and Wetzel, 1985; Emmons and Feer, 1997; Eisenberg and Redford, 1999). *E. sexcinctus* also occurs in the savannas of Sipaliwini in Suriname, and of Paru in the Brazilian state of Pará. Together the records in these two savanna regions constitute what has been thought to be a disjunct population, separated by hundreds of kilometers from the main distribution to the southeast (Silva Júnior and Nunes, 2001).

Silva Júnior *et al.* (2001) recorded *E. sexcinctus* from 27 localities in the state of Maranhão, between the Rios Gurupí and Parnaíba, in the region known as "Pré-Amazônia Maranhense." From northernmost Brazil, Silva Júnior and Nunes (2001) added four additional localities for this species in the state of Amapá, immediately to the north of the mouth of the Rio Amazonas. It is important to note that these records by themselves do not confirm a continuous distribution of *E. sexcinctus* in the Brazilian states of Amapá, Pará, Maranhão and Piauí. Here we record this species from the region between the Rios Tocantins and Gurupí in Pará, and suggest its continuous distribution in the Brazilian Amazon.

Methods

Data collection and morphological characterization

We identified *E. sexcinctus* from animals that had been hunted by local people in the municipalities of Bragança, Ourém, Augusto Corrêa, and Vizeu in the state of Pará, and in Bocaina in the state of Piauí (Table 1). Local residents donated the specimens during interviews carried out when we were conducting mammal surveys in this region. From the six animals donated to us, it was only possible to preserve the carapace and skull of a single specimen, now in the Zoological Collection of the Campus of Bragança in Bragança, Pará, under the field number *196PA*. Only blood and muscle tissue could be collected from the other five specimens. We identified these individuals from the information provided in Emmons and Feer (1997), Eisenberg and Redford (1999), Nowak (1999), and Silva Júnior and Nunes (2001).

Molecular characterization

We used molecular markers to confirm the morphological identification of *E. sexcinctus* and examine intraspecies similarities of the sampled animals. We chose *Dasypus novemcinctus* and *Cabassous unicinctus* as outgroups, and obtained the sequences from a sample collected in the state of Pará and another sample supplied by GenBank, respectively. The GenBank accession numbers for *C. unicinctus* are AF232016 (cytochrome *b*) and Z48940 (16S rRNA).

For the molecular characterization, two mitochondrial genes with different rates of evolution were chosen: cytochrome *b* (protein coding gene) and 16S rRNA (ribosomal RNA). Genomic DNA was extracted from small quantities of blood or ear tissue of the collected specimens. DNA extraction was performed in accordance with the conventional phenol-chloroform extraction protocol modified from Sambrook and Russell (2001).

TABLE 1. New locality records for *Euphractus sexcinctus*. Mesohabitat: 1 = clear-cut region, located between an urban area and mangrove; 2 = small fragments of secondary forest and salt marshes associated with mangroves; 3 = clear-cut region with small fragments of secondary forest; 4 = Caatinga region.

Specimen Code	Location	Coordinates	City/State	Ecosystem	Mesohabitat
E.sex. 194PA	Bacuriteua	46°44'22.8"W, 00°58'23.4"S	Bragança/PA	Dry Land	1
E.sex. 196PA*	Salinas Farm	46°40'11.5"W, 00°55'21.3"S	Bragança/PA	Mangrove	2
E.sex. 73PA	Gavião Real Farm	47°06'52"W, 01°33'07"S	Ourém/PA	Dry Land	3
E.sex. 17PA	PA - 454	46°38'06"W, 01°01'18"S	Augusto Corrêa/PA	Dry Land	3
E.sex. 36PA	PA - 242	46°08'24"W, 01°11'48"S	Vizeu/PA	Dry Land	3
E.sex. 33PI	Malhada	41°19'21"W, 06°56'33"S	Bocaina/PI	Caatinga	4

* Carapace and skull preserved.

Fragments of nearly 600 base-pairs of both 16S and cytochrome *b* genes were isolated by PCR (Polymerase Chain Reaction), using the oligonucleotides described by Palumbi *et al.* (1991) and Smith and Patton (1993), respectively. DNA was sequenced using the ABI Prism™ Dye Terminator Cycle Sequencing Ready Reaction kit (Applied Biosystems, USA), on an ABI 377 (Perkin Elmer) automated sequencer. PCR and sequencing procedures were conducted in accordance with those described by Barros *et al.* (2003).

Phylogenetic analysis

Sequences were aligned and edited with BIOEDIT (Hall, 1999) and ClustalX (Thompson *et al.*, 1997). The phylogenetic analyses were performed with a series of programs, including DAMBE (Xia and Xie, 2001), Modeltest (Posada and Crandall, 1998), MEGA2 (Kumar *et al.*, 2001) and PAUP* (Swofford, 1998). Cluster significance was estimated by Bootstrap analysis (Felsenstein, 1985).

Results

The nucleotide sequences of the DNA fragments were approximately 600 base pairs for each of the two genes we examined (16S and cytochrome *b*). All sequences were submitted to GenBank (Accession Numbers DQ243709–DQ243724). The nucleotide divergence matrix, built according to the Kimura two-parameter model for the two gene segments examined, showed a divergence of less than 3%. Genetic distances among

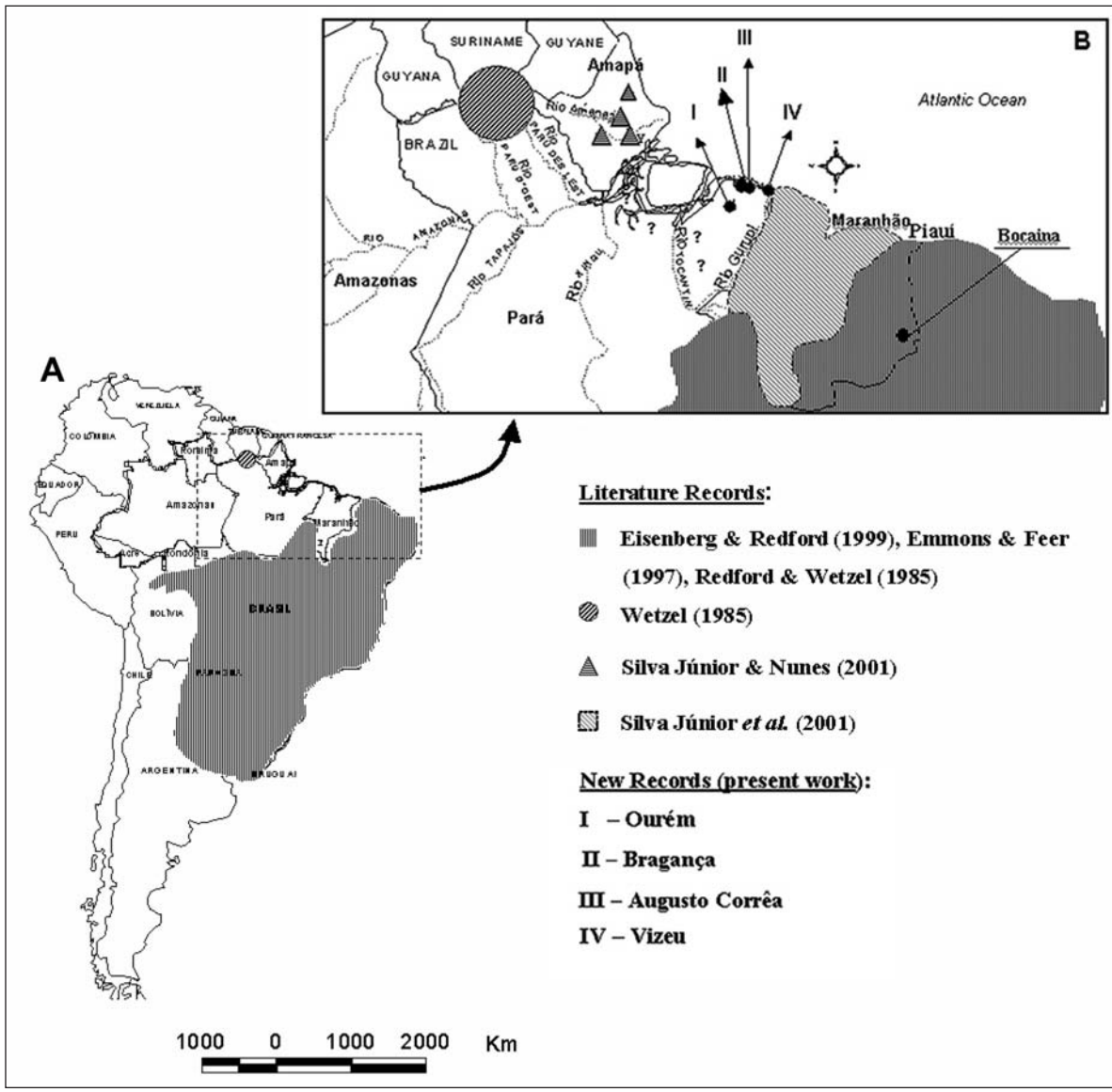

FIGURE 1. Geographic distribution of *E. sexcinctus* in South America (a) and the new records which expand this species' distribution northward in the Brazilian Amazon (b).

E. sexcinctus specimens captured in different habitats ranged from 0.2 to 1.3% for the cytochrome *b* gene and from 0.6 to 2.8% for the 16S rRNA (Tables 2 and 3). The distance approach among species using cytochrome *b* resulted in divergences slightly above 22% for the *E. sexcinctus* and *D. novemcinctus* specimens, whereas the comparative analysis with *C. unicinctus* produced values ranging from 21–24.7% (Table 2). The same approach using 16S rRNA resulted in lower values, which averaged 15.6% between *E. sexcinctus* and *D. novemcinctus*, while *C. unicinctus* averaged less than 11.1% (Table 3).

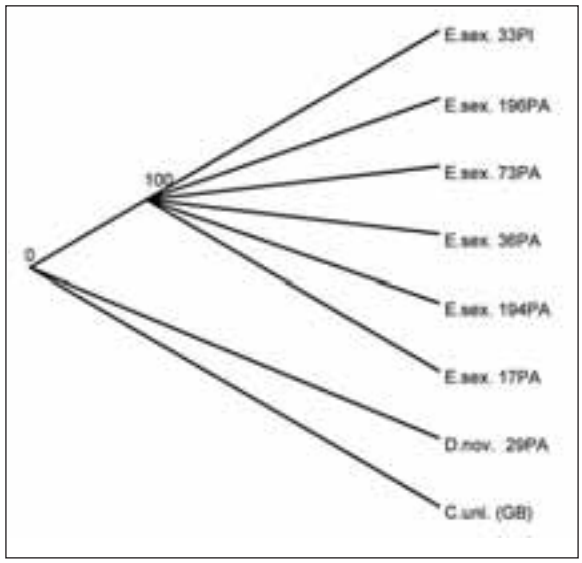

FIGURE 2. Neighbor-joining tree of a partial fragment of cytochrome *b*, with *D. novemcinctus* and *C. unicinctus* as outgroups. The high bootstrap values support the validity of this topology.

The four methods for performing the phylogenetic analysis (Maximum Parsimony, Neighbor-Joining, Minimum Evolution and Maximum Likelihood) generated trees of identical topology. Specimens of *E. sexcinctus*—regardless of origin, gene segment analyzed, or different methods of analysis—were always included in the same clade (Fig. 2) with high statistical support (bootstrap = 100%), matching the low divergence values found in individuals of this genus. Similarly, a high genetic divergence was found among the three different genera, a fact that was also confirmed by the relationships within the resulting phylogenetic trees.

Discussion

The degree of divergence among the five individuals of *Euphractus sexcinctus* was much less than that among the three armadillo genera. The strong similarity among these five individuals, acquired from dif-

TABLE 2. Distance method analysis of mitochondrial cytochrome *b* gene for *E. sexcinctus, D. novemcinctus* and *C. unicinctus.*

Cytochrome *b*	E. sexc. 33PI	E. sexc. 17PA	E. sexc. 194PA	E. sexc. 36PA	E. sexc. 73PA	E. sexc. 196PA	D. nove. 29PA	C. unic. GB
E. sex. 33PI	-							
E. sex. 17PA	0.002							
E. sex. 194PA	0.004	0.002						
E. sex. 36PA	0.002	0.000	0.002					
E. sex. 73PA	0.013	0.011	0.013	0.011				
E. sex. 196PA	0.004	0.002	0.004	0.002	0.013			
D. nov. 29PA	0.226	0.229	0.232	0.229	0.238	0.226		
C. uni. (GB)	0.213	0.210	0.213	0.210	0.218	0.207	0.247	-

TABLE 3. Distance method analysis of the mitochondrial 16S rRNA gene for *E. sexcinctus, D. novemcinctus* and *C. unicinctus.*

rRNA 16S	E. sexc. 194PA	E. sexc. 73PA	E. sexc. 196PA	E. sexc. 36PA	E. sexc. 33PI	E. sexc. 17PA	D. nove. 29PA	C. unic. GB
E. sex. 94PA	-							
E. sex. 73PA	0.019							
E. sex. 96PA	0.009	0.015						
E. sex. 36PA	0.019	0.028	0.017					
E.sex. 33PI	0.009	0.017	0.006	0.015				
E.sex. 17PA	0.011	0.017	0.006	0.019	0.009			
D.nov. 29PA	0.155	0.163	0.150	0.166	0.153	0.147		
C.uni. (GB)	0.104	0.111	0.099	0.114	0.101	0.102	0.143	-

ferent localities and ecosystems, suggests that the Rio Gurupí is not a barrier to gene flow in the *Euphractus* populations of this region.

These new locality records support the suggestion of Silva Júnior and Nunes (2001) that the disjunct range of *E. sexcinctus* may be an artifact of undersampling, rather than a genuine division. The records we present here extend its known distribution to the interfluve between the Rios Tocantins and Gurupí. Taken together with the localities presented by Silva Júnior and Nunes (2001) and Silva Júnior *et al.* (2001), it seems likely that *E. sexcinctus* is continuously distributed at least to the southern margin of the mouth of the Rio Amazonas. Additional surveys between the Rios Tocantins and Xingu may provide evidence of a much broader total range than had been previously assumed.

Acknowledgments: We are grateful to the Instituto do Milênio for financial support. We also want to thank both the Laboratory of Mangrove Ecology and the Laboratory of Genetic and Molecular Biology of the Federal University of Pará (UFPA) for logistical support. Frederic Delsuc, Liliana Cortés-Ortiz and Paula Lara-Ruiz kindly reviewed the manuscript and offered valuable comments. The first author was supported by a fellowship from the Brazilian Scientific and Technological Council (CNPq: Process N°. 390007/2004-8).

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Research Questions on the Behavior and Ecology of the Giant Armadillo (*Priodontes maximus*)

Dennis A. Meritt Jr.

Between 1972 and 1982, five giant armadillos (*Priodontes maximus*) resided for varying periods in an off-exhibit area at the Lincoln Park Zoo in Chicago, Illinois. They included three males which came from Guyana and two females from Bolivia, all received as wild-caught young adults. Together they were the subjects of observations by animal care staff and volunteer docents, who made almost daily observations on the overall activity, food consumption, and general behavior of the giant armadillos. Zoo personnel also recorded weights and body measurements at regular intervals, as well as basic physiologic values such as body temperature and respiratory rates. The presence of *Priodontes* in the collection stimulated a number of communications, visits and inquiries from individuals and organizations interested in its natural history and behavior. Together with field excursions to giant armadillo habitat in the Chaco of Paraguay and northern Argentina (Meritt, 1973), these captive armadillos prompted the development of a detailed life history outline—one that summarized research questions related to this species, noted information not readily available or missing from the literature, and listed life history traits which are still unknown (Meritt, unpubl. ms.).

A recent field excursion to the Chaco of Paraguay, and an increase in research projects in Argentina and Paraguay, has prompted me to update and expand this outline, which is meant to serve as a guide for those studying this, the largest of the living armadillos (Ceresoli and Fernandez-Duque, 2004; Porini, 1999, 2001). Many of the study topics posed here will only be answered through the detailed study of animals in the wild, but others may be addressed through the diligent observation of animals already held in various Argentine zoos, or those under investigation in private wildlife reserves. It is my hope that anyone intending to work with *Priodontes*, or those already doing so, will consider the questions raised in this outline. I encourage anyone who is able to provide answers to any of these questions to publish their results; and likewise I welcome any additions to this list, based on the life history and behavior of the giant armadillo.

A thorough search of the literature demonstrates just how little is known about this species. Burmeister (1867a, 1867b) provided early anatomical information on the giant armadillo, including notes on its skeleton. Benirschke and Wurster (1969) provided the first chromosome count for this species, while Carter (1983) and Carter and Encarnação (1983) conducted a census of its burrows in the Serra da Canastra, Brazil. Parera (2002) provided a brief review of the status, distribution, habitat and diet of the species in Argentina, but little else is known directly, although some inferences may be made from the related forms of *Cabassous* and what is known about their natural history and behavior.

One may hypothesize that *Priodontes* is generally solitary, except during periods of sexual receptivity. While the number of young per litter is unknown, in at least two *Cabassous* species there is usually only a single offspring (pers. obs.). The gestation period is unknown, but thought to be similar to *Cabassous*; the period of maternal care is not known, and the role, if any, of the male in the rearing and protection of the young is also unknown. At the Lincoln Park Zoo, captive female *Cabassous* with developing offspring were not in the company of a male (pers. obs.) so it is not possible to make any inferences about the male's role, or even his possible threat to the offspring. Strikingly, no juvenile *Priodontes* have been discovered in the field, nor found their way into captive management. Various species of *Cabassous* have been confused for immature *Priodontes* at one time or another (pers. obs.) and have even been offered for sale by animal dealers. Whether the evidence is physical or photographic, however, none of these supposed giant armadillos have been proven to be *Priodontes*. Even in habitat known to support them, where giant armadillo activity has been demonstrated and field studies have been carried out, no young have ever been witnessed.

Our understanding of the habitat preferences of giant armadillos is also imprecise. While the present distribution of *Priodontes* has been adequately mapped, both individuals and populations are patchy in their distribution, and may be limited to islands of preferred habitat. In the Chaco of Paraguay, for example, where *Priodontes* is known and occasionally captured,